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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>A42B 3/06, A41D 31/00</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 99/11152</b> <b>(43) International Publication Date:</b> 11 March 1999 (11.03.99)
<b>(21) International Application Number:</b> PCT/GB98/02647 <b>(22) International Filing Date:</b> 3 September 1998 (03.09.98)  <b>(30) Priority Data:</b> 9718710.8 3 September 1997 (03.09.97) GB 9718709.0 3 September 1997 (03.09.97) GB 9723819.0 12 November 1997 (12.11.97) GB  <b>(71)(72) Applicant and Inventor:</b> CAYLESS, Sean [GB/GB]; The Old Coach House, Unit A, 103 Highcross Street, Leicester LE1 4PH (GB).  <b>(74) Agent:</b> LAURENCE SHAW & ASSOCIATES; Metropolitan House, 5th floor, 1 Hagley Road, Edgbaston, Birmingham B16 8TG (GB).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> PROTECTIVE WEARING ARTICLE, FOR EXAMPLE HELMET  <b>(57) Abstract</b>  An article comprises a layer of shock absorbing material and a layer of load spreading material. The article may be used to absorb shock on impact, and may be shaped for use by sportsmen and the like.		

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## PROTECTIVE WEARING ARTICLE, FOR EXAMPLE HELMET

The invention relates to protection of the human and other bodies and in particular to the protection of the body of sportsmen and other people exposed to like hazards such as security guards, cyclists, motorcyclists, military personnel, police, security officers. It is well known to use a shock absorbing material to form an outer cover such as a vest. Typically such materials tend to absorb some of the energy of the impact of a missile which may be anything from a cricket ball or knife/sharp instrument or baseball bat type weapon to a bullet. It is one object of this invention to increase the level of shock absorbency and ideally to suppress it almost completely.

According to the invention in one aspect there is provided a shock reducing article, comprising a layer formed of a shock absorbing material associated with a layer of load spreading material arranged so that on impact the load is distributed whereby a wearer experiences reduced shock.

The shock absorbing layer may be provided by a wide range of suitable materials but typically and preferably it is made of a foam which is substantially totally shock absorbing. Such a material is identified by the trade mark **MEMORY FOAM®** and is available from Astron ElastomerProdukte GmbH of A-1231 Vienna, Austria. Such foams may be made up from a wide range of materials based on nitriles, norbenones and combinations such as nitrile/pvc. Suitable foams have the following typical properties:

<i>Specific gravity</i>	0.1-0.5g/cm <sup>3</sup> and preferred ~ 0.19 g/cm <sup>3</sup> (DIN 53550 – BS903 Part A1 –
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Method A)

*Elasticity*

~ (DIN 53512)

*Hardness*

9-30 Shore A (DIN 53505 – BS 903)

Part A26-Method N)

Other shock absorbing materials may be used, either instead of or in addition to the foam. Examples include foams based on a polyethylene, polyurethane, polystyrene, polypropylene, nitrile or polynorbenone.

The loading spreading sheet may be provided by a wide range of materials such as hard pvc, polystyrene, LDPE, HDPE etc. or other materials alternative to plastics.

It is a further object of this invention to provide an article capable of absorbing trauma and able to resist attacks by knife or like sharp instruments or weapons such as baseball bats and batons.

According to this invention in another aspect there is provided an article having at least three layers comprising:

- one layer comprising a shaped body of shock absorbing material
- a layer of load spreading material
- a layer of blade resistant material

The layer of shock absorbing material may be shaped to match the contours of the body or part of the body. For example, the layer may be contoured to the bust for wear by a policewoman.

The layer which is resistant to penetration by a blade, e.g. a knife blade, may act by preventing penetration or by deflecting it. Suitable materials include chain mail, mesh of metal or suitable plastics.

The different layers may be joined into one article in a variety of ways such as heat, adhesive, stitching, riveting or the like. In some cases the layers may be loose.

The layers may be arranged in any suitable sequence, and more than one layer of any type may be present.

Examples include (working from the outside inwards)

load spreader  
mesh/mail  
load spread  
foam  
load spread  
foam

or

load spreader  
mesh,  
foam  
mesh  
load spread  
foam.

Articles may be shaped as or be incorporated in other products or garments such as helmets, hats, jacket, shoulder/neck guards, full protective vests, arm guards (upper and lower), leg guards, shin pads, butchers aprons, gloves, clothing as in shirts, blouses, jackets, vests, overcoats and the like and any corporate garment; car headrest, bumper or the like. The articles may be provided with attachments means which affix, strap on, clip-

on or otherwise fix to an individual guard, operative, etc., or animal, e.g. police horses, racing horses, dogs and the like.

In another aspect the invention provides an article of wear such as a helmet comprising shaped inner layer and a second layer making up an outer skin, wherein at least part of the skin is in the form of platelets arranged so that the force of an impact is spread whereby the wearer suffers local impact force only.

The platelets may be made of a wide variety of materials such as polyethylene, pvc, and the like; metal; fibreglass; composites; KEVLAR; or the like.

Preferably the platelets are arranged so that under a severe impact the impacted platelet will be urged inwardly into the foam to underlie an adjacent platelet, giving an overlap of platelets better able to resist any subsequent impact on that site. The arrangement of platelets will depend on their shape and the use to which the headwear is to be put.

In order that the invention may be well understood it will now be described by way of example with reference to the accompanying diagrammatic drawings in which:

Figure 1 is a cross-section through one pad article before impact; and

Figure 2 is the same cross section at or after impact.

Figure 3 is a cross-section through another article of the invention.

Figure 4 is a side elevation of one sports helmet of the invention;

Figure 5A is a cross-sectional view of a wall of one helmet of the invention in an unimpacted condition; and

Figure 5B is also a cross-sectional view following impact.

The pad shown in Figure 1 comprises a body F made of foam such as ASTRON memory foam ® measuring about 6 to 10 mm thick. A layer of semi-rigid or rigid plastics, e.g. 0.5 to 1.5 mm thick low density polyethylene, is secured by, e.g. by heat sealing with or without an intermediate sheet not shown, glueing, riveting stitching or other fixing method. The layers may however be loose. On impact, e.g. a bullet, (having been arrested by a ballistic pack usually of polyaramid fibres or the like), bat, or ball, the hard layer C will spread the load across the foam F, resulting in much reduced trauma to the wearer. Even on very hard impact the load will be spread over a wide area, and the pad may be deformed as in Figure 2, but the wearer undergoes little or no trauma.

It is well known that the United States national institute of Justice (NIJ) measured the back face deformity from arrested bullets and set a pass standard at 44 mm. More recently in the UK the Police Scientific Development Branch (PSDB) set a new lower standard of 25 mm back face deformity. In one embodiment, the use of Memory foam ® at 9 mm (in 3 layers of 3 mm) combined with 1.5 mm of LDPE has reduced back face deformity to levels of 9 mm and below placing the protective pad at the forefront of trauma protection whilst retaining lightweight and flexible characteristics unknown in prior trauma systems.

On a 25 Joule impact of soccer-shin protectors, existing shin guards achieve transmitted force levels of around 15-20 KN where the constituent parts are PE foam 6 mm + cotton +

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2 mm HDPE. Where 6 mm Memory Foam ® is used in combination with HDPE, 25 Joule impacts result in a drastic reduction of transferred force to less than 6KN.

On 50 Joule impacts, transmitted forces on traditional guards generally fall between the bands 30-45 KN. Transferred forces can reduce to less than 20KN with use of this protective pad at 50 Joule impacts.

On hard impacts of 50 Joule and above, the load is spread over a wide area, and the pad may deform as in Figure 2, but the wearer undergoes drastically reduced trauma. The pad may be incorporated in, or with as a stand alone, a pad in any protective garment, e.g. leg guard, hat, helmet, vest, jacket, shoulder pad, arm guard etc., car headrest, bumper or other. The pad may be applied to horses, e.g. police horses, racing horses or articles, e.g. vehicles.

The article in Figure 3 comprises a body F made of foam such as ASTRON memory foam® measuring about 10 mm thick. A layer of semi-rigid or rigid plastics P, e.g. 1.5 mm thick low density polyethylene, is secured by, e.g. by heat sealing with or without an intermediate sheet not shown, or other fixing method. Between the layers is a metal mesh or chain mail M or other blade resistant material. The bonding could pass through the mesh. The article of Figure 3 is multifunctional in that it provides a level of protection against cutting of skin or flesh, i.e. against stab, knife or slash attack; it spreads the impact of a blow to reduce the level of impact; it will absorb any impact to reduce risk of bruising, sprains, broken bones or the like.

The helmet of Figure 4 is an article made of the usual shape. The helmet has a main shaped body formed of a shock absorbing material F, preferably Astrons MEMORY



foam®. Platelets P may be a hard material such as polyethylene or polypropylene are spaced about the outer surface of the helmet and heat sealed, glued, welded or otherwise secured to the foam with or without an intermediate heat sealing sheet. It will be seen that there are gaps G between the platelets where the foam is exposed. Where appropriate the exposed surface may be covered with a waterproof, typically resinous or e.g. latex or fabric coating or cover which may or may not be decorated.

On impact from a missile such as a sports ball or the like the missile will typically hit one platelet P and the shock transmission will pass from the impacted platelet into the foam. Adjacent platelets may also sense the impact force but there will be no opportunity for that force to be transmitted all around the helmet because of the discontinuity. As a result the helmet will be more pleasant to wear and there will be less risk of damage requiring replacement of the helmet. As shown in Figure 5B a severe impact can dent one platelet P into the underlying foam material F to the extent that an end portion of the platelet will underlie a neighbouring platelet which has not been so deformed. The overlapping relationship provides increased resistance to further impact as a result of which even a damaged helmet may be used for a prolonged period.

The platelets shown in the drawing are spaced apart but they can be butted together, and indeed partially overlapped in fishtail manner. The underlying foam may have areas of higher or lower density underlying platelets or between platelets. Platelets may be distributed in zones, leaving areas platelet free.

The invention is not limited to the embodiments shown. More layers may be present; platelets may be located one on top of another. The headwear may be for cricket, hockey, football, horse riding, ice hockey, canoeing; windsurfing; cycling and motorcycling, etc; it

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may be a knee pad; anti-impact safety equipment such as a gym mat; anti-ballistic pad; or the like.

**CLAIMS**

1. A shock reducing article comprising a layer formed of a shock absorbing material associated with a layer of load spreading material arranged so that on impact the load is distributed whereby a wearer experiences reduced shock.
2. An article according to Claim 1, wherein the shock absorbing layer is a nitrile PVC foam.
3. An article according to any Claim 1 or 2, wherein the shock absorbing layer is a foam formed of a polyethylene, polyurethane, polystyrene, polypropylene, nitrile or polynorbenone.
4. An article according to any preceding Claim, wherein the load spreading material is hard pvc, polystyrene, LDPE, HDPE; or the like.
5. An article according to any preceding Claim, comprising a layer of MEMORY FOAM as the shock absorbing material.
6. An article according to any preceding Claim, wherein the load spreading material is a layer of low density polyethylene.
7. An article according to Claim 5 and 6, wherein the MEMORY FOAM is about 6 to 10 mm thick and the layer of polyethylene is about 0.5 to 1.5 mm thick.

8. An article according to Claim 5,6 or 7, wherein the MEMORY FOAM comprises multiple layers.
9. An article according to any preceding Claim, wherein the two layers are secured against relative movement.
10. An article according to Claim 8, wherein the two layers are glued, stitched, riveted or otherwise secured together.
11. An article according to any preceding Claim, shaped to be worn on the body and to reduce trauma on impact of a missile such as a bullet, bat or ball.
12. An article according to any preceding Claim in the form of a shin protector, leg guard, chest guard, thigh guard, body guard, hat, helmet, vest, jacket, shoulder pad, arm guard, car head rest, trauma pack, bumper for a vehicle; or the like.
13. An article according to any of Claims 1 to 12 including a layer of blade resistant material, whereby the article is additionally adapted to resist attacks by knife or like sharp instruments.
14. An article according to Claim 13, wherein the layer of blade resistant material is made of chain mail, metal mesh or plastics mesh.
15. An article according to Claim 13 or 14, comprising layers (from outside inwards):

layer of load spreader

layer of mesh or mail

layer of load spreader

layer of shock absorbing material

layer of load spreader

layer of shock absorbing material

or

layer of load spreader

layer of mesh or mail

layer of shock spreader

layer of mesh or mail

layer of load spreader

layer of shock absorbing material

16. An article according to any of Claims 1 to 15 in the form of a helmet, comprising a shaped inner layer and a second layer making up an outer skin, wherein at least part of the skin is in the form of platelets arranged so that the force of an impact is spread whereby the wearer suffers local impact force only.
17. An article according to Claim 16 as dependant on Claim 4, wherein the second layer may be additionally formed of metal, alloy, fibreglass; polyaramide; fibre composite; or the like.
18. An article according to Claim 15 or 16 in the form of a helmet for a cyclist or for a sportsman, e.g. for cricket or hockey.

19. An article according to any of Claims 15 to 17, wherein the exposed surface of the first layer is coated or covered with a wax, resin or fabric.
20. An article according to any of Claims 15 to 18, wherein the platelets are butted together or each slightly overlaps its neighbour.

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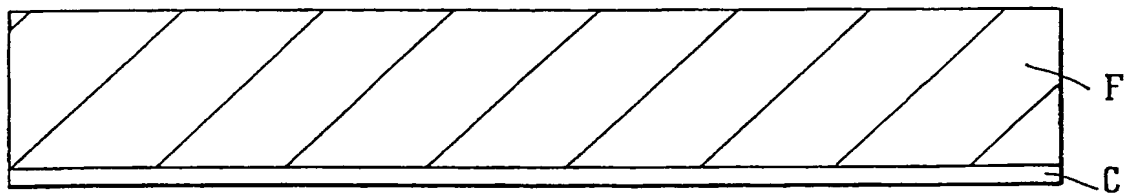


FIG. 1

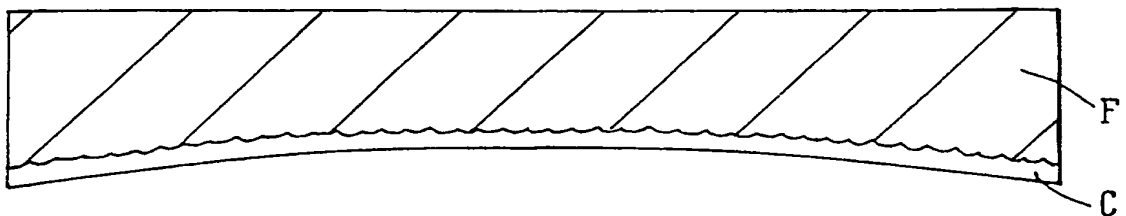


FIG. 2

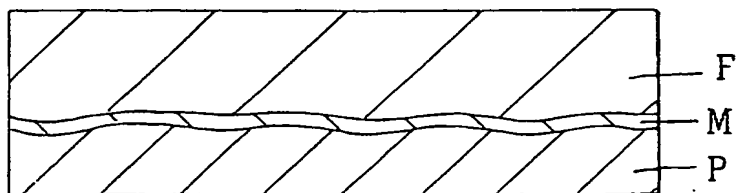


FIG. 3

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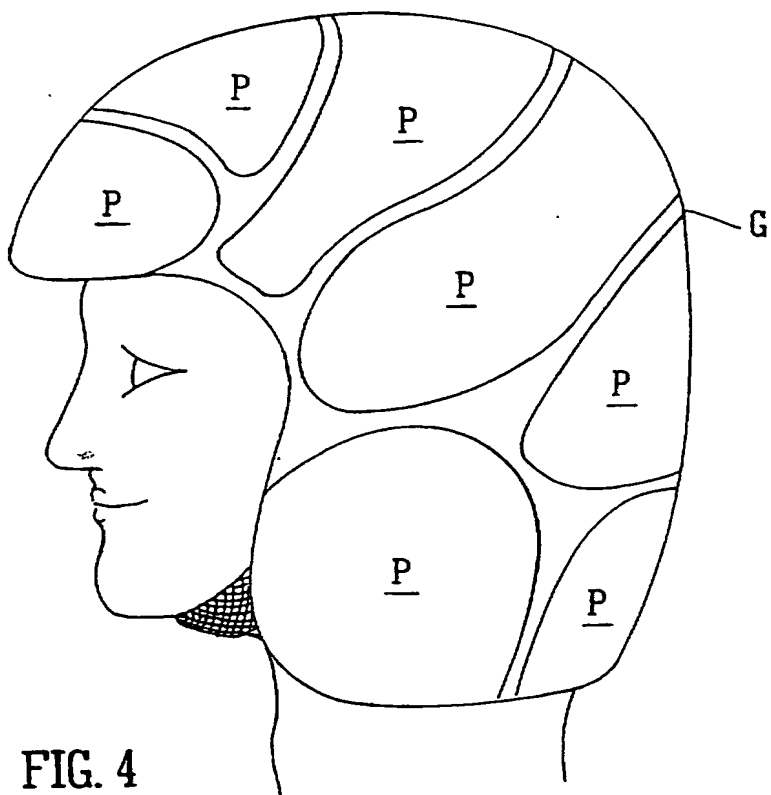


FIG. 4

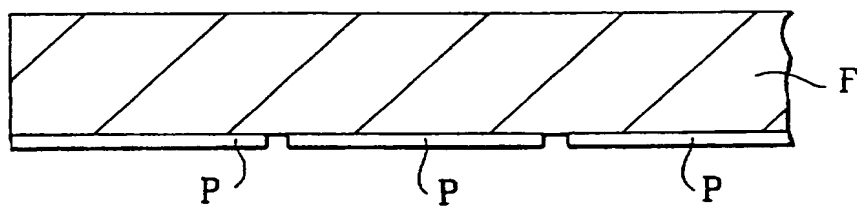


FIG. 5A

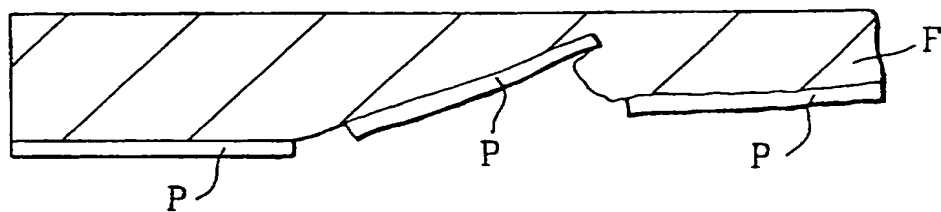


FIG. 5B



# INTERNATIONAL SEARCH REPORT

Internat. Application No.

PCT/GB 98/02647

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 A42B3/06 A41D31/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A42B A41D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 21 33 215 A (MINE SAFETY APPLIANCES COMPANY) 13 January 1972 see page 1, paragraph 1 - page 3, paragraph 1 see page 4, paragraph 1 - page 6, paragraph 1 see figures 1-4	1,9-12, 16,18,19
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A	---	2-6
	-/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

14 December 1998

Date of mailing of the international search report

23/12/1998

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# INTERNATIONAL SEARCH REPORT

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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